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Teaching, Learning and Evaluation Techniques in the Engineering Courses

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Teaching, Learning and Evaluation Techniques in the Engineering Courses

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Abstract- *This article presents some techniques of professional formation from the Petra Model that can be applied in Engineering Programs. It shows its philosophy, teaching methods for listening, making abstracts, studying, researching, team working and problem solving. Some questions regarding planning and evaluation, based in the model are, as well, discussed. Finally is shown a proposal of application of the model with basis of the EFEI's experience.*

Introduction

The Petra Model of professional formation [1], created by Siemens in Germany, has the objective of correct the profile of the egresses from traditional professional formation systems, which was considered unsatisfactory by the enterprises, not only in technical issues, but as well, and mainly, in relation to several personal qualities demanded to any professional.

The paper " PETRA Model: An Alternative for Engineering education" [2], published in the proceedings of ICEE97, shows an overview of this model, emphasizing its historical and philosophy, showing the 39 personal qualities developed and the tutor and student's role in the PETRA.

Basically, the objective of the application of this model is to sensitize and promote in the student a series of personal characteristics, such as leadership, initiative, involvement, discipline, determination, cooperation, team working, planning ability, problem solving, self-assessment, research ability, concentration, transference and many others. It is known that the enterprises are looking for professional with something else a part from technical skill. Matthew O. Sadiku [3], reports the results of a research inquiring about factors that influence in the managerial promotion. It shows that technical competency, acquired by experience is ranked in the nineteenth position in a list of twenty-two items. All other characteristics are personal qualities, such as the one mentioned previously.

This article, suggests techniques to be implemented, targeting the development of some personal qualities in the students and propose the application of them and the evaluation method, based in the experience of Escola Federal de Engenharia de Itajuba - EFEI.

The Petra Philosophy

The philosophy of the PETRA model can be understood through the phrase of the Chinese philosopher Kuan Tzu:

> *If you give a man one fish, he will feed himself once. However, if you teach him to fish, he will feed himself for all his life.*

In this context, to get the food can be understood as seek information, team working, problem solving, etc. However, the students are not oriented adequately to deal with these situations and facing the firsts defeats, can discourage and make them unmotivated to achieve these tasks.

To give the fish, means to give information, models or solutions, performed roles, generally, by the tutor. It is important to mention that presenting solutions to a problem is not wrong, on the other hand can be used to do something else, like *teach to fish*, which means to teach to seek information, team working, problem solving, etc. The adequate positioning of the tutor should be:

- listen to the student attentively to find out which is the real problem;
- to present or remind needed information to solve a problem, without giving the solution;
- to show the way of solving the problem;
- observe and reinforce the performances presented by the student;
- to assess the student performance and
- demonstrate satisfaction by the success achieved and stimulate e encourage the student.

This is the PETRA philosophy. If the student needs to do a series of activities by himself and the tutor realize that the student's performance in this issue is not satisfactory, he must, initially, be concerned in developing the qualities in the student.

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Generally, the used techniques in the PETRA sensitize the student, through games or simulations, to the importance of the intended personal quality for development. Afterwards, the tutor use a certain teaching style (lectures, brainstorm, circular discussion, Philips 66, etc.) to the students learn the basics principles involved in that quality. Finally, create conditions to each student perform the learnt quality (attitude), observing and reinforcing on the performance.

Teaching the Students to Listen

In a lectured class, it is not unusual, to see a lack of learning results, due to the unawareness of the importance of learning something by listening. Teaching to listen, must be one of the firsts concerns of the tutor, because part of knowledge is transferred to the students by means of this quality.

As a suggestion, the tutor can , initially, the game *Empathy Group*, that consist in to divide the students in groups of three or four and propose a subject discussion without previous studying. The only rule of the discussion is that before express your own opinion, the student must explain the ideas presented by the previous colleague. This technique sensitize the student about the need of listening attentively to increase the efficacy of interpersonal communication and shows the relation between promptness to listen and other qualities, such as attention, concentration, empathy, judgment and dialogue maintenance.

Finally, the tutor applies the **mini-class** technique, using the text "How to listen" [1] in order the students learn the basic principles involved in this quality. This text shows a research about interpersonal interaction and tells that we spend, in average, 75% in verbal communication, while we are awoke and of this: 40% speaking and 60% listening. Therefore, for instance, from 16 hours that someone spend awoke, 12 hours, in average, he will be interacting verbally with other persons. From this 12 hours, he will speak around 5 hours and listen approximately 7 hours. However, the text affirms that the majority of the people do not know to listen! And after presents 25 items related to this quality.

One Summarize Technique

During research activities the students need to summarize the collected materials to present them afterwards to their colleagues or, even, tutor. However, there are, three difficulties: lack of orientation by the tutor, the students preference in analyzing or synthesize and the compression of the researched material due to the style of authors, absence of pre-requisites or vocabulary problems. Therefore, it is important that the tutor teach this ability from the student before demanding it.

As a suggestion, the tutor could apply a Phillips 410 to rise opinions about the theme: "which orientations do you take to summarize texts?" After, he presents and discusses with the students the five basic orientations to make an abstract:

1. Read, with attention, all text, answering the question: "what is the subject about?" Give a title to the read material and compare with the one proposed by the author.
2. Limit the abstract extension: 10% to 25% of the original text.
3. Analyze each text paragraph, underlining the main ideas and secondary. If necessary, make notes in the margin of the text.
4. Synthesize each paragraph in one or two phrases.
5. Link paragraphs phrases by expressions to adjust the language and chaining thoughts. After the orientations, choose one text, asking t the students, following the given instructions of how to summarize, make an abstract of it. The tutor must create conditions to each student use the skills learnt, accompanying them when they are summarizing texts, reinforcing the wished performance.

A Research Technique

Research is an activity that the students perform frequently, but not always, are oriented formally to accomplish such task. Follows, below, some useful orientation is this subject:

- limit clearly the research theme;
- make a word and ideas survey related to the theme that could help the search of documents for consulting (books, magazines, articles, videos, movies, catalogues, etc.);
- find, in the library the available documents linked to the theme that will satisfy your needs;
- analyze the selected books reading the cover notes, preface, and summary;
- choose the chapters that can have pertinent information;
- read each selected chapter to verify if they have the wished information;
- study each one of the chapters of interest;
- analyze other selected documents;

- make a summary containing surveyed information in the selected documents;
- make a book list and other consulted documents;
- show the results of your research in oral or written way.

One Study Technique

The study skill, performed since the beginning of our lives at school, is seldom taught or oriented by teachers. Due to this, here are some simple suggestions to study a text:

- read through the text to obtain an quick overview of the subject;
- make a second reading to rise doubts, signing the unknown words or expressions, parts of difficult understanding or important issues;
- eliminate doubts, discussing with colleagues, consulting dictionary, or searching for source of information including the tutor;
- read once more the text, with the objective of understand it;
- solve the proposed exercises in the text or by the tutor;
- correct the exercises, taking the opportunity of doing a review of what was learnt.

How to Work in Group

One essential requisite, to any student or professional, is the capacity of work in-group. The job market demands one professional with this profile, due to the enterprise activities that have many interpersonal relations with each other professionals envisaging common objectives of work. This problem gains special relevancy in the PETRA model development, due to the majority of the personal qualities defined in the model refer to the student while a member of a group: cooperation, discipline, empathy, involvement, initiative, judgment, leadership under emergency, dialogue maintenance, arguing objectivity, participation, self-limitations recognition, etc.

The PETRA model shows seven simple techniques to teach the students to work in group: *mini-class*, brainstorming, GVGO, integrated panel, reporting panels and Philips 66, to be applied in real working situations. Due to the extension of the subject, please refer to specialized bibliography like [1], [4] and [5].

Other interesting resource to complement and retain the groups learning performances, are games and specifics simulations to these aims. However, not usually clear to the tutor, the classroom game is away of teaching, specially selected to reach established objectives. For instance, the following games can be applied: NASA game, Empathy Group, X and Y Game, The Tower Game [1], [6].

The experience shows that the knowledge itself of group work techniques does not guarantee the solution of all practical problems that might arise during its application. The tutor must take in consideration some basic rules to facilitate the activities management:

- prepare the students to work in group;
- makes small groups of 2 to 7 members;
- group the students either randomly or by special criteria like: professional affinity or interests, age, alphabetic order, physical proximity, etc.;
- avoid to keep the students at the same group many times, giving opportunities of learning and working with different partners;
- follow the group works, reinforcing the wished performances or making needed adjustments;
- obey sharply the defined timing, showing discipline;
- make the learning place as a true "laboratory", teaching, observing, reporting and assessing the performance of the group work activity.

Solving Problems Ability

During the school activities, the students need, by the tutors' request, solve problems in order to learn new subjects, complement or fix something already learnt. Solving problem can be understood as a knowledge combination, skills and work techniques already learnt, in a creative way that take to new findings, subsiding the students to search of intended solutions. Some orientations to this are:

- identify clearly the problem;
- analyze it to find its possible causes;
- establish one priority order between causes;
- rise alternatives to eliminate the causes;
- select and test the alternative that has more probability of solving the problem;
- in case the first alternative selected and tested do not solve the problem, select and test other until find the solution of the problem.

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Planning and Assessment

Any educational activity must be carefully planned and evaluated by the instructor. These procedures avoid the improvisation and seem to increase substantially the efficacy of the tutor's work.

The teaching planning is a educational decision taking process that involves 3 phases: analyze (think before act), plan elaboration (report the results at the moment of thought) and execution (act according to the thought).In the PETRA model, is up to the tutor the elaboration of: one long term plan, project development plans and steps of procedures to the project development.

It is up to the student the elaboration of: execution plans, evaluation of the project and its technical description.

The assessment in the PETRA model is based in four levels of performance of the personal qualities: reproduction, reorganization, transference and problem solving. The student and the tutor pass, gradually and progressively, for each level, from reproduction to problem solving. The assessed student passes from one level to other level according to the tutor's assessment.

One Application Proposal

It is important mention that in this work is presented, summarized, only some techniques of the PETRA model. To get a effective application of the methodology, it is necessary to train the tutor through 5 phases. The 1st, 3rd and 5th consist of courses of 40 hours each, and the 2nd and 4th phases are application of the methodology during the following 6 months of each one.

Other important condition to the PETRA model application is the existence of a allocated time in the curriculum, for teaching theses subjects, which, sometimes is difficult. To solve this problem at EFEI, the 1st phase of the model took place with twenty lecturers and a plan was made to the application of some essential techniques diluted during the last two years of the Electrical Engineering Program. This planning is presented as follow:

Semester	Applied Techniques
6º Period	Presentation of PETRA Model
7º Period	A technique to listen A technique to summarize A technique to research A technique to study
8º Period	A technique to work in a group A technique to plan
9º Period	A technique to transfer apprenticeship A technique to solve problems
10º Period	Design development with PETRA Model Student's final evaluation

Conclusion

This article showed, succinctly, some of the several techniques of the PETRA model for professional development. The main objective of it was to provoke the interest of the readers, tutors and students, in the described issues. The experience of the application of this methodology at EFEI during the past two years,

had shown, very positive results. It is possible to observe clearly the accentuated students' development by the use of the model.

Other important aspect to mention is the great interest demonstrated by the students, when oriented by the methodology. It is clear the urgent want of human relations' issues by the part of the students.

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